Stabilization of Sb in MSWI bottom ash in view of its recycling as construction material

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New regulations on recycling of waste as secondary raw materials that include more stringent limit values for the leaching of Sb are being introduced. However, only little is known about the leaching mechanisms of Sb. Recent studies suggest that the mobility of Sb is influenced by the formation of calcium antimonate, adsorption to iron (hydr)oxides, incorporation of Sb in ettringite (Cornelis et al., 2012), or the formation of iron antimonate (Okkenhaug et al., 2013). To lower Sb leaching from MSWI bottom ash (BA) and to determine the main Sb stabilization mechanism(s), 2.5% CaO, 5% $CaCl_2$, 5% $CaCO_3$, 2.5% $Fe_2(SO_4)_3$ and 1% $FeCl_3$ were added to the sand fraction (0.6-2 mm) of MSWI BA. To investigate whether organic acids like humic and fulvic acids, which are known to form aqueous complexes with Sb (Steely et al., 2007), also play a role in the leaching of Sb from BA, BA was either heated at 400°C in a muffle furnace, carbonated (30°C, 0.2 atm partial CO_2 pressure, 20% moisture content), or mixed with 5% activated carbon. All samples were submitted to a 24h leaching test (EN12457-2), and the concentrations were compared with those from a pH dependent leaching test on BA.

Figure 1 shows that all additives decrease Sb leaching and that their influence is not only related to the pH change of the matrix. When combinations of both Ca- and Fe-containing compounds were added, their effects were additional, indicating that Ca and Fe containing additives involve different Sb binding mechanisms. Carbonation tests on BA with Ca- and/or Fe containing compounds (not shown) indicated that the effects of the additives also endured on the long term.

Sb leaching after heating, carbonation and addition of activated carbon is shown in Figure 2 and the behavior is comparable to Cu leaching (not shown). It is hypothesized that organic acids also play an important role in the leaching behavior of Sb from BA. The decreased leaching is explained by mechanisms known for Cu leaching (Arickx et al., 2006): heating induces decarboxylation of organic acids and activated carbon adsorbs the organo-metallic complexes, or Sb itself. Carbonation leads to formation of new Fe/Al (hydroxides), to which Sb (or the organic complex) is adsorbed, which is favored by the decreased pH. These results confirm that the addition of Ca and/or Fe containing compounds can decrease Sb leaching to below regulatory limit values. Furthermore, they confirm the important role of organic acids in Sb leaching, and show that also heating, carbonation and the addition of activated carbon can decrease Sb leaching, and therefore increase the recycling options for MSWI BA.

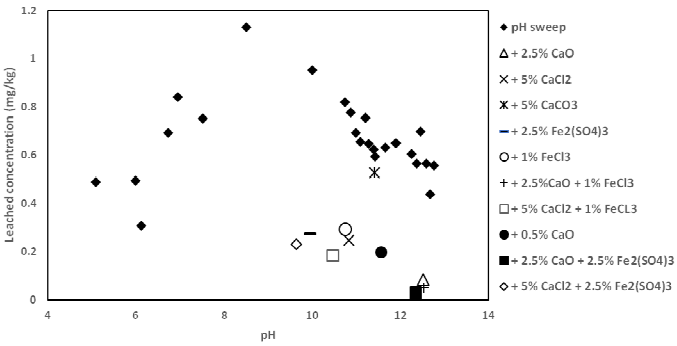

Figure 1: Sb leaching from MSWI BA after addition of Fe-and Ca-containing compounds.

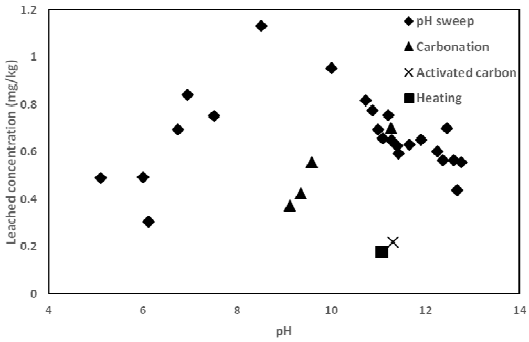

Figure 2: Sb leaching from MSWI BA after carbonation, activated carbon addition and heating

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